

MEMO

TO: Tom Fikslin

DATE: October 5, 2010

FROM: Ron MacGillivray

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SUBJECT: Criteria for Assessment of Radioactive Waste in Hydraulic Fracturing Flowback Wastewater

Naturally Occurring Radioactive Material (NORM) - low-level radioactivity that can exist naturally in native materials, like some shales, may be present in drilling cuttings and other wastes from a well. Oil and gas production and processing operations sometimes cause NORM to accumulate at elevated concentrations in byproduct waste streams. The primary radionuclides of concern are isotopes of radium that originate from the decay of uranium and thorium naturally present in the subsurface formations from which oil & gas are produced. The production wastes most likely to be contaminated by elevated radium include produced water, scale, and sludge. Radium²²⁶ is an alpha emitter and radium²²⁸ is a beta emitter.

	NE-PA 2008 frac wastewater sample pCi/L	Range of NORM in produced water ^a pCi/L	DRBC stream quality objectives pCi/L	EPA MCL pCi/L
radium ²²⁶	2.37	0.054-32,400		combined radium 226/228 5
radium ²²⁸	10.12	8.1-4,860		combined radium 226/228 5
Gross alpha	12,600		3	adjusted gross alpha ^b 15
Gross beta	6,516		1,000	
Beta particle and photon radioactivity				8 pCi/L 4 mrem/yr

- a) JONKERS, G., HARTOG, F.A., KNAEPEN, A.A.I., LANCEE, P.F.J., “Characterization of NORM in the oil and gas production (E&P) industry”, Radiological Problems with Natural Radioactivity in the Non-Nuclear Industry (Proc. Int. Symp. Amsterdam, 1997), KEMA, Arnhem (1997) as reported in International Atomic Energy Agency Safety Reports Series No 34, Radiation Protection and the Management of Radioactive Waste in the Oil and Gas Industry.
- b) Adjusted gross alpha does not include radon or uranium.

Additional radioactive components of oil and gas production include lead²¹⁰, polonium²¹⁰, radon²²², strontium⁹⁰, thorium²³² and uranium²³⁸.

Lead²¹⁰, Strontium⁹⁰ and Thorium²³² are regulated by EPA under the Safe Drinking Water Act authority to establish maximum contaminant levels (MCLs) for beta emitters in public drinking water. The EPA MCL for beta emitters is 4 millirem per year or 8 picoCuries per liter (pCi/L). DRBC stream quality objective for gross beta is 1,000 pCi/L.

Polonium²¹⁰ is an alpha emitter, and therefore, it would fall under the EPA MCL for alpha particles which is 15 pCi/L. DRBC stream quality objective for gross alpha is 3 pCi/L.

Uranium²³⁸ is regulated under the Clean Air Act. Uranium isotopes undergo radioactive decay by emission of an alpha particle accompanied by weak gamma radiation. The maximum dose to an individual from uranium in the air is 10 millirem. Uranium in drinking water is covered under the Safe Drinking Water Act. The uranium limit is 30 µg/l (micrograms per liter) in drinking water. The DRBC does not have a stream quality objective for uranium.

Radon²²² monitoring in air at drilling sites to limit exposure is a recommended component of radiation protection and management in oil and gas production. Currently, radon has no federally-enforced drinking water standard. EPA has proposed to require community water suppliers to provide water with radon levels no higher than 4,000 pCi/L.

The EPA has classified all radionuclides as human carcinogens.